Patent Application

of

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for

RETROFIT HURRICANE-EARTHQUAKE CLIP

Background-Field of Invention

This invention relates to an innovative retrofit connector that permanently connects the roof to the outside wall to create buildings that are stronger and more resistant to hurricanes and earthquakes.

Background-Description of Prior Art

Background

Recent studies of hurricane damage on wood-frame buildings indicate that extensive damage was generated to a house by strong winds, when the roof rafters or roof trusses twisted or were torn from the outside wall.

Roof sheathing ties all the rafters or purlins together on a wood frame house, and the roof sheathing ties all the roof trusses together when a masonry or wood-frame house is constructed with trusses. If the rafters or trusses rack or twist from the wind forces, the roof sheathing can detach from the roof allowing rain to enter the house.

Sheathing that is tightly secured to the rafters or trusses and subsequently fastened to the walls, helps transfer uplifting forces to the walls and henceforth to the foundation. The leading edge of a roof is the weakest point of sheathing uplift during strong winds, and this invention helps prevent any roof uplift.

Failure of the outside wall sheathing is common during hurricanes, because of inadequate fastening of the sheathing to the underlying structural members. This invention helps prevent the wall sheathing from splitting, racking, and detaching from the wall. The extreme negative pressure of a hurricane blows out the sheathing from walls, but this invention holds the sheathing tight to the walls, as sheet metal joints perform better than nailed joints in high winds and during seismic activity.

Hurricanes

Studies of damage after Hurricane Andrew show several problems with the attachment of roof rafters and roof trusses that this invention solves.

Roof overhangs act like wings, creating huge uplifting forces during strong winds. This uplift tears apart the rafters that are toe-nailed to the header or top plate. The uplift can also twist rafters and roof trusses weakening the toenailed connections and causing detachment.

The one thing that ties together the top plate, studs, and sill plate is the outside sheathing. This invention effectively ties together the rafter, top plate, and outside wall sheathing to form a continuous load-path to the sill plate. Attaching my invention to the rafter and top plate junction puts the nails perpendicular to the uplifting force and would require shearing the nails in order to lift the rafter or truss.

One significant factor in building construction is precision framing, where the rafter is installed directly above the stud. Unfortunately, in existing houses this is rarely the case.

Post-and-beam construction is very common in older homes in mild-weather areas, and we have found that the wall studs, or in this case, posts, are only under every fourth rafter, and the rafters can be 4-feet on center. Usually, the posts are directly under where the top plate butts up against the top plate in the run. The rafter is to one side of this butt joint, so the rafter does not line up directly over the post.

On newer stud-wall construction, we have seen that studs rarely line up directly under the rafters. We saw houses where the walls have studs 16-inches on center, constructed with a roof that had rafters 24-inches on center. This means the only rafter and stud that will line up to form a continuous load-path is every fourth stud or every other rafter. The odds are low that they will exactly line up.

Another problem with home construction is on mis-installation of prior art hurricane clips that are made for new

construction and covered by wall sheathing. After Hurricane Andrew, there were many examples of careless and inferior attachment of hurricane clips or they were entirely missing. One company has visited new construction sites and documented many examples of shoddy and incorrect application of their products.

To achieve a continuous load-path on existing houses the outside sheathing must be taken into account. The most important tie in an existing house is between the rafter and top plate or roof truss and top plate. Any uplifting wind force on the roof must be transferred to the walls. In tropical climates, the roof purlin, an intermediate structural member, may separate from the rafter with the roof sheathing.

My invention effectively ties together the rafter or roof truss, top plate, and outside sheathing (and indirectly, the wall studs) to form the most practical and economical continuous load path from the roof to the foundation.

Earthquakes

During an earthquake, the floor, wall, and roof diaphragms undergo shearing and bending. Because of the difference in weight, a roof can move at different speeds than the walls. The shear forces from the roof boundary members are transferred to the top of the shear wall by way of toenails to the top plate. To withstand and transfer the shear loads, the connection between the roof and wall must be strong.

The outside sheathing provides lateral stability to the walls, preventing racking. The sheathing also absorbs and transfers earthquake forces by becoming a shear wall.

An earthquake can send motion into a house and separate the sheathing from the walls. The sheathing can come loose from the walls by the nails popping out or the plywood splitting away from the nails driven on it's edge. Some codes allow sheathing to be stapled to the wall studs, which is a weak connection. This invention helps prevent the outside sheathing from pulling away from the wall during earth movements.

Steel connectors, between different components of a wood-

frame buildings superstructure, provide continuity so that the building will move as a unit in response to seismic activity (Yanev, 1974). This invention ties the walls securely to the roof, so the house will move as one unit.

Prior Art

A number of connectors have been developed to tie together the structural members of a house under construction. Up until this invention, nobody had seen how to make a retrofit connector that could tie sheathing to the underlying structural members and connect to the side or "meat" of a rafter or roof truss without having material hanging down.

My co-pending applications, serial numbers 08/958,267, and 09/001,744 are retrofit hurricane clips. Although the `267 can be mounted on 2x rafters, it was designed for large timber rafters such as 4x stock, and has a web member that can be seen from the side. The `744 uses a saddle and side webs for lateral support, and can not be seen from the side, hence it is stealth-like.

The leading manufacturer of wood construction connectors, the Simpson Strong-tie Company, shows no retrofit hurricane connectors in their catalog. They do have a variety of connectors for use in new construction that ties the rafter to the top plate including: H1, H2, H2.5, H3, H4, H5, H6, H10, H7, H15, H10-2, and HS24. None tie the wall sheathing to the wall, none tie the roof sheathing to the rafter and top plate, and only the H10 ties the blocking to the rafter and top plate.

The H10 by Simpson appears to be a bendable tie that has horizontal slots along the center for bending the top part down. The H10 appears to be field bent by the carpenter to fit on the blocking, something that homeowners won't want to do on their homes. The slots weaken the metal, and if the 18 gauge material can be bent in the field, the connection is pretty weak.

There are a number of ties that fasten the rafter to the top plate while a house is being constructed including: Knoth US Patent Number 5,561,949, McDonald US Patent Number 5,560,156, Colonias US Patent Number 5,380,115, Stuart US Patent Number

5,335,469, Callies US Patent Number 5,230,198, Colonias et al US Patent Number 5,109,646, Commins US Patent Number 4,714,372, Gilb US Patent Number 4,572,695, Gilb et al US Patent Number 4,410,294, and Maxwell et al US Patent Number 2,413,362.

These are good inventions, but they are difficult to retrofit onto existing houses without demolition of existing parts on a house. None were designed or patented to be retrofit on to an existing house.

The prior art hurricane clips provide little lateral strength, even when using a left and right. The prior art cannot tie the outside sheathing to the underlying top plate and roof rafter. They cannot clear frieze boards and prevent the outside sheathing from being sucked off during the extreme negative pressure of a hurricane.

The prior art inventions do not prevent the outside sheathing from splintering and disconnecting during earth tremors. They do not have multiple uses such as tying the roof sheathing to the rafter and top plate at the leading edge of the roof, which is the weakest point in a wood-frame house in a hurricane or tornado.

Frye's anchor system, US Patent Number 5,311,708, is patented as a retrofit, but it does not tie the rafter to the top plate, cannot clear frieze boards, and ties into the weakest thin edge of the rafter while splitting it with bolts. Frye's 708 also provides no lateral support against side movements.

Netek's reinforcing tie, US Patent Number 5,257,483, is patented as a retrofit and may clear frieze boards, but it is temporary, and like Frye, ties into an even weaker thin edge of the end of the rafter. Netek's 483 also provides no lateral support against side movements.

There are several retrofit apparatus for securing roofs using cables. Adams US Patent Number 5,570,545 and Winger US Patent Number 5,319,896 are both temporary, meaning a homeowner must be home to deploy and anchor the ephemeral cables. The anchors can only be as secure as the nearby soil and the cables

do not prevent the walls from bowing or blowing out.

There are a number of joist hangers that fasten to a joist and vertical member while a house is being constructed including: Colonias et al US Patent Number 5,104,252 and Gilb US Patent Number 4,480,941. These are good inventions, but they provide little lateral strength, and they are difficult to retrofit onto existing houses.

Joist hangers have a small ledge that supports all the weight from the joist beam. They hang the weight from the edge, rather than supporting the weight on top of the edge. They are also thin and parallel to the long dimension of the joist beam, concentrating all that carrying weight onto a vertical thin-section of the vertical member.

Gilb's complicated hanger, US Patent Number 4,261,155, is strong, but cannot be retrofit on to a house.

Prior art connectors relied on angled nailing, to provide lateral support, which is complex to manufacture, and very difficult to install on a completed house.

Objects and Advantages

Accordingly, several objects and advantages of my invention are that it helps secure the roof and wall of a building to make the building a solid unit and preventing it from being destroyed by hurricanes and earthquakes.

This invention helps prevent the roof from being blown off the walls of an existing building. It keeps the roof rafters and roof trusses tightly secured to the outside sheathing and underlying top plate of the wall.

This invention helps prevent the roof rafters and roof trusses from twisting during strong winds, thereby preventing detaching of the roof material and underlying roof sheathing. It stiffens the edge of the roof and the top of the wall, helping to transfer lateral loads to the whole roof and walls.

This invention helps prevent the wall sheathing of a building from detaching from the wall studs during an earthquake. It helps make the outside wall into a stable shear-wall,

transferring shear forces into the foundation and ground.

One object of this invention is to make each outside wall on a house into a shear-wall, that is, able to transfer forces without breaking or disconnecting. By tying the outside sheathing securely to the top plate and rafter or roof truss, the plywood can reliably transfer and dissipate shear, lateral, and uplift forces to the ground.

During an earthquake or a hurricane, a building with my invention will be a sturdy unit, resisting and transferring destructive forces to the ground.

Many older homes were constructed with the best materials and competent carpenters, but used the time-honored method of connecting the rafter to the top plate with nails driven into the edge of the rafter. This weak connection, called toe-nailing, is still in use today to hold roof trusses to the top plate. Even if prior art hurricane clips were used in construction of a house, the homeowner can't tell, and those clips don't hold the outside wall sheathing to the wall.

Mounted on the roof rafter or roof truss, my invention resists uplift, the most destructive force during a hurricane. Mounted on the top plate and wall sheathing, my invention prevents the wall sheathing from being blown off or sucked out by the extreme negative pressure of a hurricane.

During an earthquake, when my clips are mounted on the roof and walls, they will make each member into a shear wall. The secured plywood will absorb and dissipate earth movements, without becoming detached from the underlying structural members. It will also prevent the sheathing from sliding past each other.

This would improve the house beyond existing building codes, as sheet metal joints have been proven to perform better than nailed joints during hurricanes and earthquakes.

Another object of this invention is the large surface area. This area prevents the outside sheathing from splitting during hurricanes or earthquakes. The large surface area provides more strength in the connecting or hold-down process.

Yet another advantage of this invention is during earthquakes, nails can sometimes bend with the movements of the house, but screws often break. This invention absorbs and transmits most of the forces during an earthquake and hurricane so nails and/or screws can be used as fasteners.

Another advantage is that since the invention absorbs and transfers earthquake and hurricane forces, less nails and nailing could be used. Also, screws could be used in the invention in earthquake areas with less fear that the heads will shear off.

Still another advantage of the invention is in the ability to prevent plywood sheets from sliding past or over each other during an earthquake. Previously, only nails had to shear, but this entire connector must be sheared for the invention to fail.

Still another advantage is that with the roof rafters and roof trusses better able to resist twisting, roof sheathing will stay firmly attached and roofing material will now have a better chance of staying on during strong winds and earth movements. In addition, with the sheathing now firmly connected, new materials may be attached to the roof, such as solar electric panels, without fear of them being blown off.

In areas with brush or forest fire danger, fire-proof material or heavy material, such as tile, stone or metal, can now be applied to the roof with less danger of being blown or shaken off during earth tremors or high winds. Fire-proof materials such as stucco or brick veneer can be applied to the wall sheathing with less chance of being shaken off during earth movements.

Earth tremors and hurricanes always destroy the weakest parts of a house. By making each envelope of a house, the vertical walls and roof envelope into a strong unit, there will be less damage.

It is a further object of this invention that it easily, quickly, and economically protects houses from the destructive forces of earthquakes and hurricanes. It is a still further object that the connectors and fasteners are strong, attractive, permanent, functional, uncomplicated, simple to manufacture, easy

to install, and economical. All of the embodiments can be made from a single sheet metal blank, without any welding.

A further object is that this invention can be used on various size sheathing, rafters, roof trusses, studs, wood or metal I-beams, TJI, and glue-lams, all made from wood or metal. There may be insurance discounts for homeowners who have this invention installed on their houses.

As a retrofit, a handy homeowner can install this invention, or have it installed. The homeowner can easily see that the home is protected instead of wondering if hurricane clips were installed correctly during construction, or installed at all.

Traditional toe-nailing of the rafter is at the bird's-mouth, a notch cut into the rafter where it rests on the top plate. By cutting out material from the rafter, a bird's-mouth weakens the rafter. Toe-nailing only two nails from either side grasps only a small edge of the rafter, and the nail only extends into the top 2x of the top plate.

Tests were done by the Colorado School of Mines on my co-pending retrofit hurricane clip, application serial number 08/958,267. The tests showed that the rafter split lengthwise, due to uplifting force, before my 267' clip failed.

This new retrofit invention strengthens the rafter to top plate connection by vastly increasing the spacing and amount of nails in the thickest part or "meat" of the rafter. This clip also strengthens the bird's mouth by wrapping on either side of the rafter and keeping it from splitting along the long measure.

As a retrofit, an insurance agent can observe that the home is protected and give appropriate discounts. Perspective home buyers can perceive that the building is protected, so the seller has a good selling point and can ask for a better price.

Since these clips are a retrofit, and are not covered by sheathing or gypsum board, the invention is much thicker than prior hurricane clips and tensile values are dramatically increased.

Another advantage is with the top webs angled away from

vertical, they form an upside-down flying buttress. This tremendously increases resistance to outward thrusts. This makes the roof much stronger and able to resist more weight such as thick snow, ice, or volcanic ash, and heavy roofing material such as tile, insulated roofing, solar collectors, and satellite dishes.

This invention takes the place of a left and right prior art hurricane clip, thus cost and installation time is substantially reduced. Installation can be accomplished with a power nailer or powered screw gun.

The left and right tabs, and the angled seat combine to cradle the rafter, significantly increasing lateral strength over prior hurricane clips. The angled seat carries no weight of the rafter, since the bird's mouth cut of the rafter distributes the weight onto the top plate. The flat edge of the roof truss would also place no weight on the angled seat, hence the angled seat can have a curved shape, angled shape, compound angles, flat seat, or rounded seat.

Since this invention cradles the rafter or roof truss on the bottom, and left and right side, and has a wide base anchored to the outside wall, torsional twisting of the rafter is significantly reduced over prior art hurricane clips, as is cross-grain splitting.

Since the left and right tabs, and the angled seat combine to significantly increase lateral stiffness, no part of the invention hangs below the rafter, hence it is invisible from the side. Architects and homeowners approve that this retrofit hurricane clip is concealed.

The left and right tabs, that are installed on opposite sides of the rafter have offset nail holes. Nails driven into the rafter will be offset from each other lessening wood splitting and vastly increasing holding power.

This invention does not require any removal of frieze boards or wood trim from the house. On houses where a frieze board is installed between rafters or roof trusses, this invention has an

offset between the top and base webs that allows the invention to be installed as a retrofit. The offset clears any frieze board, wires, or trim that sticks out from the wall.

If the frieze board is warped or is slanted away from the house, the angled top web's position will clear it. If the frieze board is angled on one side of the rafter and straight on the other side of the rafter, this invention will still not be hindered in being retrofit on to a house.

The cyclone clip can hold down roofing material and roof sheathing. This invention can hold down roof sheathing to the rafter or roof truss, providing great rigidity to the entire house. This makes the house significantly more resistant to strong winds and earth tremors.

In tropical climates, where hurricanes are common, roof purlins are used to support the roof sheathing, usually corrugated metal roofing, which is too thin to fit between standard rafters. This invention can hold down a roof purlin and corrugated metal roofing. It can also hold down curved roof tiles, shakes, and shingles.

Edges of the clip are slightly rounded for strength, ease of handling, and avoiding stress fracturing associated with sharp corners.

These and other objectives of the invention are achieved by simple and economical connectors that allow a builder or home owner to quickly and easily secure the weakest parts of a building against earth tremors and high winds. The weakest parts being the rafter to top plate connection, the leading edge of roof sheathing, and the attachment of wall sheathing.

Advantages of each will be discussed in the description. Further objects and advantages of my invention will become apparent from a consideration of the drawings and ensuing description.

Brief D scription of th Drawings

FIG. 1 is a perspective view of a typhoon clip.

FIG. 2 is a side view of a typhoon clip.

FIG. 3 is a front view of a typhoon clip installed on a house.

FIG. 4 is a flat pattern layout of a typhoon clip.

FIG. 5 is a flat pattern layout of a cyclone clip.

FIG. 6 is a side view of a cyclone clip installed on a house.

Ref r nce Num rals in Drawings

1. Typhoon clip
2. Right blocking web
2A. Nail holes
3. Left blocking web
4. Right rafter bend
5. Left rafter bend
6. Rafter vertical cut
7. Left rafter web
8. Right rafter web
8A. Nail holes
9. First horizontal bend
10. Right rafter horizontal cut
11. Left rafter horizontal cut
12. Second horizontal bend
13. Offset web
14. Base web
15. Seat
16. Cyclone clip
17. Base plate
17A. Nail holes
18. First level bend
19. Offset tab
20. Second level bend
21. Right rafter prone cut
22. Left rafter prone cut
23. Right blocking tab
23A. Nail holes
24. Left blocking tab
25. Right rafter tab
25A. Nail holes
26. Left rafter tab
27. Right rafter upright bend
28. Left rafter upright bend
29. Rafter steep cut
30. Left sheathing tab
31. Right sheathing tab
32. Left strengthening tab
33. Right strengthening tab
34. Left sheathing bend
35. Right sheathing bend
36. Bolt holes
36A. Oblong holes
37. Right strengthening cut
38. Left strengthening cut
39. Roof plate
40. Steel plate
41. Carriage bolt
42. Perch
43. Nut
44. Grommet
45. Hollow rivet
F. Frieze boards or blocking
M. Roofing material
R. Rafter or roof truss
S. Roof sheathing
T. Top plate
W. Wall sheathing

Description

The present invention is a sheet metal retrofit connector for joining wood members on a building, such as a roof rafter **R** and outside wall sheathing **W**. During a hurricane, it prevents the roof rafter **R** from disconnecting from the outside wall sheathing **W**, and underlying top plate **T** by uplifting forces. The typhoon clip **1** prevents the outside wall sheathing **W** from detaching or bowing out from negative pressure extremes generated by a hurricane. It also prevents the wall from bowing in when on the windward side of the hurricane.

The typhoon clip **1** prevents detachment and sliding of the outside wall sheathing **W** from lateral forces during an earthquake. This clip makes the outside wall sheathing **W** into an extremely stable shear wall; and ties the top plate **T** and roof rafter **R** securely to this shear wall making it resistant to most earth tremors.

Besides these very important functions, the typhoon clip **1** is a retrofit and is very easy to install on completed houses. The innovative offset web **13** clears frieze boards or blocking **F**, warped frieze boards, wires, and wood trim under the rafters, so no demolition is required.

The rafter webs **7** and **8** cradles the rafter **R** on two sides, no matter what the slope is of the roof. The rafter webs **7** and **8** will also easily fit on rafters made up of roof trusses, glue lams, engineered wood I-beams, or metal beams. The rafter webs **7** and **8** are simple to attach to the rafter with nails or screws.

The base web **14** is easily attached to the outside sheathing **W** with nails or screws. The wide rafter webs **7** and **8**, on either side of the rafter **R** provide plenty of room for hammering, hammer-gun, or electric screwdriver. If the outside walls are made of brick or masonry all the way up to the rafter, holes can be marked, drilled with a carbide drill, and inserted with lead-type anchors. Common screws can then be used to install the base web **14**.

Sheet metal connectors have been proven to perform better than nailed connections under stresses of strong winds and earth tremors. This invention is very easily installed on a pre-existing house without disassembly or destruction of the house. If a soffit is located on the house, it is not structural, so it can be taken down and reinstalled when the typhoon clips are installed. Once installed, the house is much stronger than just nailed connections and more sturdy than prior art connectors that are installed during construction of a building.

The invention can be easily installed as a retrofit at the weakest connection of a house, during a hurricane, the rafter **R** to outside wall sheathing **W** and underlying top plate **T**. This is also a weak connection during an earthquake, as the roof is heavier than the walls and moves at a different rate which can tear the roof from the walls.

FIG. 1

Refer now to FIG. 1, which shows a perspective view of a typhoon clip **1**. In the preferred form of the invention, a large base web **14** has nail holes **14A** spaced to prevent splitting the outside wall sheathing **W**, while holding the sheathing **W** tightly to the wall.

The nail holes **14A** on the top part of the base web **14** provide nailing through the outside wall sheathing **W** and into the top plate of the top plate **T**. The nail holes **14A** on the lower part provide nailing through the outside wall sheathing **W** and into the bottom plate of the top plate **T**.

Above the base web **14**, a shallow second horizontal bend **12** bends the offset web **13** away from the wall of the house. This provides room for the typhoon clip **1** to clear frieze boards or blocking **F** on an existing house. It also provides clearance for wires that may be strung under the rafter **R**.

On the top part of the offset web **13** is a shallow first horizontal bend **9** that bends the blocking webs **2** and **3** back toward the house, but not quite vertical. This places the blocking webs **2** and **3** next to the blocking **F**.

A right angle at the right rafter bend **4**, and cut at the right rafter horizontal cut **10** form a right rafter web **8**. A right angle at the left rafter bend **5**, and cut at the left rafter horizontal cut **11** form a left rafter web **7**.

The left rafter web **7** and right rafter web **8** are separated by a cut at the rafter vertical cut **6**. A standard rafter **R** from a rafter or truss can be accommodated in the opening formed between the left rafter web **7** and right rafter web **8**.

Use of the typhoon clip **1** on an existing house is simple. The typhoon clip **1** is inserted onto a rafter **R** from underneath the rafter and slid upward. The base web **14** will be flush against the outside wall **W**, and the offset web **13** will deposit the left rafter web **7** and right rafter web **8**, on the appropriate sides of the rafter **R**.

The seat **15** formed by the left and right horizontal cuts **10** and **11** will be flush against the bottom of the rafter **R**. This cradles the rafter **R** on three sides. Nails or screws can be driven through the nail holes **8A** on the left rafter web **7** and right rafter web **8** into opposite sides on the wide part of the rafter **R**.

Nails or screws can be driven into the nail holes **14A** of the base web **14** through the outside sheathing **W** and into both plates of the top plate **T**. Nails or screws can be driven into nail holes **2A** on the right blocking web **2** and left blocking web **3** into the frieze board or blocking **F**, next to the rafter **R**.

FIG 2

Refer now to FIG. 2 which shows a side view of a typhoon clip **1** installed on a house. Only the left side of the typhoon clip **1** can be seen in this view. The base web **14** is attached to the outside wall sheathing **W** and to both plates of the underlying top plate **T** by nails through nail holes **14A**.

The second horizontal bend **12**,the offset web **13**, and the first horizontal bend **9** place the blocking webs **2** and **3**, and rafter webs **7** and **8** away from the wall and at an acute angle from vertical.

By being away from the wall and angled, the frieze board or blocking **F** can be cleared by the typhoon clip **1**. Frieze boards **F** are mounted so as to form a drip edge along the bottom so moisture won't drip down the wall, but away from the wall. This prevents prior art connectors from working as a retrofit on houses with frieze boards **F**.

The right blocking web **2** and left blocking web **3** can be attached to the frieze boards or blocking **F**. The right rafter web **8** and left rafter web **7** can be attached to the rafter **R**. This connects the rafter **R**, blocking **F**, outside wall **W**, and top plate **T** securely together.

Many houses have been built with the outside wall sheathing **W** attached to the wall with staples or small nails. Many rafters **R** have been attached to the top plate **T** by toe-nailing, or driving nails at an angle into the thin edge of the rafter R and into the top plate **T**. This is a very weak connection. Thin prior art hurricane clips were only connected to the rafter **R** and top plate **T**, and covered by the wall sheathing **W**.

If a house has blocking or frieze boards F, they are usually toe-nailed into the rafters. Now, with a typhoon clip **1** installed on an existing structure, the rafter **R**, blocking **F**, outside wall **W**, and top plate **T** are now clamped together securely.

The previously weak connection between the roof and wall is now anchored together. If hurricane winds try to lift the rafter **R**, the blocking **F**, wall sheathing **W** and top plate **T** are now secured together and will collectively resist uplift.

If strong winds hit the house wall, shown in FIG. 2, from the right, pressure will try and push the wall **W** in. Many rafters **R** were birds-mouthed, or had a flat notch cut on the bottom to prevent thrusting or the roof weight trying to push the wall outward. Only the toe-nailed connection prevented the wall from being blown in. Now the typhoon clip's strong connection to the rafter **R** and blocking **F** will prevent the wall from moving inward.

If the strong winds hit the house wall from the left, internal house pressure tries to blow the wall outward. The

typhoon clip **1** forms an upside-down buttress, with the rafter webs **7** and **8**, and offset web **13** forming the angled buttress stay that prevents the wall sheathing **W** from bowing outward or detaching from the wall.

Earthquakes can push a house upward and shake it side to side. The upward movement can detach the roof from the wall because it is heavier and would have more momentum. Side or lateral movement can detach or twist the rafters. The typhoon clip **1** prevents the rafter **R** from twisting, moving side-to-side, or detaching from the top plate **T** and outside wall **W**.

Another advantage shown in this side view is that nothing hangs down below the rafter **R**. When the typhoon clip **1** is painted to match the house, it will not be noticed. This appeals to homeowners and architects.

The typhoon clip's strong connection between the rafter **R**, outside wall **W**, and top plate **T** prevent detachment between the roof and wall during upward movement. The strong connection between the rafter **R**, frieze board **F**, and top plate **T** prevent twisting or detachment of rafters **R** and top plate **T**.

FIG. 3

Refer now to FIG. 3 which shows a front view of a typhoon clip **1** installed on a house. This view shows another advantage of the typhoon clip **1**. The rafter **R** extends out toward the reader. In order to attach the typhoon clip **1** to a house, the connector is slid up under the rafter **R**. This means that nails or screws under the rafter **R** will be difficult to install.

By deleting the nail holes and material from the base web **14** that is directly underneath the rafter **R**, material is saved during manufacture. The chevron shape of the typhoon clip **1** takes the material from the bottom and puts in on the rafter webs **7** and **8** where it is needed for strength along the rafter **R**.

The rafter **R** is supported from moving laterally by the blocking webs **2** and **3**, and the seat **15**, formed by horizontal cuts **10** and **11**. The rafter **R** is prevented from moving up by the strong attachment to the top plate **T**, blocking **F**, and outside wall **W**.

FIG. 4

Refer now to FIG. 4 which shows a flat pattern layout of a typhoon clip 1. The chevron shape of the clip can be clearly seen in this figure, before cutting and bending. It can also be seen how the typhoon clip 1 "nests", or prevents any wasted material as the bottom of one clip nests with the top of the next clip during manufacture.

The large base web **14** has nail holes **14A**. Above the base web **14**, a shallow second horizontal bend **12** can bend the offset web **13** away from the wall of the house. On the top part of the offset web **13** is a shallow first horizontal bend **9** that can bend the blocking webs **2** and **3** back toward the house, but not quite vertical.

A right angle at the right rafter bend **4**, and cut at the right rafter horizontal cut **10** form a right rafter web **8**. A right angle at the left rafter bend **5**, and cut at the left rafter horizontal cut **11** form a left rafter web **7**. When the rafter webs **7** and **8** are bent out, a seat **15** is left on the offset web **13**.

The left rafter web **7** and right rafter web **8** are separated by a cut at the rafter vertical cut **6**. A standard rafter **R** from a rafter or truss can be accommodated in the opening formed between the left rafter web **7** and right rafter web **8**. Nails or screws can be driven through the nail holes **8A** into the rafter **R**.

The right blocking web **2** and left blocking web **3** are connected to the rafter webs **7** and **8**, and to the offset web **13** by bends. The blocking webs **2** and **3** are attached to the blocking or frieze boards **F** by nails or screws driven through the nail holes **2A** into the blocking **F**.

FIG. 5

Refer now to FIG. 5 which shows a flat pattern layout of a cyclone clip. The typhoon clip **1** could be made from the same square shape as the bottom 75% of this drawing, saving money during tool and die making. The cyclone clip **16** is similar to a typhoon clip **1** except the cyclone clip **16** has strengthening tabs

and can be mounted to the roof. The "nesting" shape also saves material.

The cyclone clip **16** has a large base plate **17** with nail holes **17A** spaced to prevent splitting the outside wall sheathing **W**, while holding the sheathing **W** tightly to the wall.

The nail holes **17A** on the top part of the base web **17** provide nailing through the outside wall sheathing **W** and into the top plate of the top plate **T**. The nail holes **17A** on the lower part provide nailing through the outside wall sheathing **W** and into the bottom plate of the top plate **T**.

Above the base web **17**, a shallow second level bend **18** bends the offset plate **19** away from the wall of the house. This provides room for the cyclone clip **16** to clear frieze boards or blocking **F** on an existing house. It also provides clearance for wires that may be strung under the rafter **R**.

On the top part of the offset plate **19** is a shallow first level bend **20** that bends the blocking tabs **23** and **24** back toward the house, but not quite vertical. This places the blocking tabs **23** and **24** next to the blocking **F**.

A right angle at the right rafter bend **27**, and cut at the right rafter prone cut **21** form a right rafter tab **25**. A right angle at the left rafter upright bend **28**, and cut at the left rafter prone cut **22** form a left rafter tab **26**.

The left rafter tab **26** and right rafter tab **25** are separated by a cut at the rafter steep cut **29**. A standard rafter **R** from a rafter or truss can be accommodated in the opening formed between the left rafter tab **26** and right rafter tab **25**.

The preceding is basically the same as a typhoon clip **1**. The following will show that the difference is on the top part, which can be attached to the roof.

The right strengthening cut **37** separates the right sheathing tab **31** from the right strengthening tab **33**. This allows the right rafter tab **25** and attached right strengthening tab **33** to bend up toward the viewer. The right strengthening tab **33** can be bent down, perpendicular to the right rafter tab **25** forming a three-

sided box.

Looking at FIG. 5, the right blocking tab **23** forms the floor of the three-sided box. The right rafter tab **27** forms the left wall, and the right strengthening tab **33** forms the adjacent top wall. The right sheathing tab **31** can be bent up toward the viewer, on top of the right strengthening tab **33**. This gives added strength to the three-sided box.

There can be different order of bending, such as bending the strengthening tab **33** over the sheathing tab **31**, depending on the tool and die maker. As long as there is a box shape for strength.

The box shape prevents lateral movements of the rafter **R**, when the right rafter tab **25** is attached to the rafter using nail holes **25A**, and the right blocking tab **23** is attached to the blocking **F** using nail holes **23A**. The right sheathing tab **31** on top of the right strengthening tab **33** forms a stiffening section against sideways, and in and out movements.

The left top side of the cyclone clip **16** is formed similarly as the right side. The left strengthening cut **38** separates the left sheathing tab **30** from the left strengthening tab **32**. This allows the left rafter tab **26** and attached left strengthening tab **32** to bend up toward the viewer. The left strengthening tab **32** can be bent down, perpendicular to the left rafter tab **26** forming a three-sided box.

Looking at FIG. 5, the left blocking tab **24** forms the floor of the three-sided box. The left rafter tab **26** forms the right wall, and the left strengthening tab **32** forms the adjacent top wall. The left sheathing tab **30** can be bent up toward the viewer, on top of the left strengthening tab **32**. This gives added strength to the three-sided box.

There can be different order of bending, such as bending the strengthening tab **30** over the sheathing tab **32**, depending on the tool and die maker. As long as there is a box shape for strength.

The box shape prevents lateral movements of the rafter **R**, when the left rafter tab **26** is attached to the rafter using nail holes **25A**, and the left blocking tab **24** is attached to the

blocking **F** using nail holes **23A**. The left sheathing tab **30** on top of the left strengthening tab **32** forms a stiffening section against sideways, and in and out movements.

The cyclone clip **16** can be attached to existing buildings in the same manner as the typhoon clip **1**. The sheathing tabs **30** and **31** do not have to be utilized. The sheathing tabs **30** and **31** can be used when new roofing material is added, or when more time or money is available.

Use of the cyclone clip **16** on an existing house is simple. The cyclone clip **16** is inserted onto a rafter **R** from underneath the rafter and slid upward. The base plate **17** will be flush against the outside wall **W**, and the offset plate **19** will deposit the left rafter tab **26** and right rafter tab **25**, on the appropriate sides of the rafter **R**.

The perch **42** formed by the left and right prone cuts **21** and **22** will be flush against the bottom of the rafter **R**. This cradles the rafter **R** on three sides. Nails or screws can be driven through the nail holes **25A** on the left rafter tab **26** and right rafter tab **25** into opposite sides on the wide part of the rafter **R**.

Nails or screws can be driven into the nail holes **17A** of the base plate **17** through the outside sheathing **W** and into both plates of the top plate **T**. Nails or screws can be driven into nail holes **23A** on the right blocking tab **23** and left blocking tab **24** into the frieze board or blocking **F**, next to the rafter **R**.

If the sheathing tabs **30** and **31** and strengthening tabs **32** and **33** are to be utilized, a hole will have to be drilled up, through both bolt holes **36**, to the top of the roof. A hole will be on each side of the rafter R.

On top of the roof, a roof plate **39** is placed over the drilled holes so that the oblong holes **36A** are in-line with the drilled holes. Carriage bolts **41** or similar bolts are inserted through oblong holes **36A** on the roof plate **39** and down through the roof and into the bolt holes **36** on the cyclone clip **16**.

The roof plate **39** is comprised of a generally flat steel

plate **40**. Since the steel plate **40** will be exposed to the elements, it can be of stainless steel, or painted to match the roof. It can be copper-coated or made from strong plastics or man-made material. It can be textured to match shake shingles or have an s-curve shape or c-shape in order to fit the hills and valleys of a clay tile roof. It can have an arch in the middle in order to hold down solar panels or satellite dishes. FIG. 5 shows a standard roof plate **39**.

The roof plate **39** can be rectangular square, or curved. A diamond-shape or a banana-shape would look pleasing from the street and will shed water when installed with the point or arch, toward the top of the house.

By having the sheathing tabs **30** and **31** folded on top of the strengthening tabs **32** and **33**, there is a double thickness of material around the bolt holes **36**. When the carriage bolt **41** is inserted through the bolt holes **36**, a nut **43** can be tightened from below the roof.

This effectively ties the roofing material **M** and roof sheathing **S** to the rafter **R**, blocking **F**, top plate **T**, and outside wall **W**. This prevents the roof from detaching during strong winds. It also ties the roof securely to the wall so that seismic events can not shake a house apart.

When the cyclone clip **16** is produced at the tool and die shop, a grommet **44** can be inserted between the sheathing tab **30** and **31**, and the strengthening tab **32** and **33**. The grommet **44** would tie both flat metal pieces solidly together. A hollow rivet **45** in the center would still allow the threaded shaft of the carriage bolt to enter. Tying both tabs together adds lateral strength to the clip when it is not installed to the roof plate **39**, and can prevent shear loads to the carriage bolt **41**.

FIG. 6

Refer now to FIG. 6 which shows a side view of a cyclone clip **16** installed on a house. The bottom and middle part of the cyclone clip **16** is basically the same as a typhoon clip **1**. The top part is different because the clip can tie into the roof.

Only the left side of the cyclone clip **16** can be seen in this view. The base plate **17** is attached to the outside wall sheathing **W** and to both plates of the underlying top plate **T** by nails through nail holes **17A**.

The second level bend **18**,the offset plate **19**, and the first level bend **20** place the blocking tabs **23** and **24**, and rafter tabs **25** and **26** away from the wall and at an acute angle from vertical.

By being away from the wall and angled, the frieze board or blocking **F** can be cleared by the cyclone clip **16**. Frieze boards **F** are mounted so as to form a drip edge along the bottom so moisture won't drip down the wall, but away from the wall. This prevents prior art connectors from working as a retrofit on houses with frieze boards **F**.

The right blocking tab **23** and left blocking tab **24** can be attached to the frieze boards or blocking **F**. The right rafter tab **25** and left rafter tab **26** can be attached to the rafter **R**. This connects the rafter **R**, blocking **F**, outside wall **W**, and top plate **T** securely together.

Many houses have been built with the outside wall sheathing **W** attached to the wall with staples or small nails. Many rafters **R** have been attached to the top plate **T** by toe-nailing, or driving nails at an angle into the thin edge of the rafter R and into the top plate **T**. This is a very weak connection. Thin prior art hurricane clips were only connected to the rafter **R** and top plate **T**, and covered by the wall sheathing **W**.

If a house has blocking or frieze boards F, they are usually toe-nailed into the rafters. Now, with a cyclone clip **16** installed on an existing structure, the rafter **R**, blocking **F**, outside wall **W**, and top plate **T** are now clamped together securely. The sheathing tabs **30** and **31** bent on top of the strengthening tabs **32** and **33** respectively, help prevent lateral and twisting movements of the rafter.

As added security on a cyclone clip **16**, a roof plate **39** can be easily mounted above an installed cyclone clip **16**. FIG. 6 shows just the left side of the cyclone clip **16**, but the same

goes for the right side. Before installing a roof plate **39**, a hole had been drilled up through the bolt holes **36** on the overlapping left strengthening tab **32** and left sheathing tab **30**.

On top of the roof, a roof plate **39** is placed over the drilled holes with the oblong holes **36A** over the holes. The oblong shape allows for mis-drilled holes and locks the carriage bolt so it cannot turn. In this way no one has to stay on the roof and hold the bolt from turning. Carriage bolts 41 are then dropped into the oblong holes **36A** and down through the roof.

Underneath the roof, the carriage bolt on the left side of the rafter **R** has dropped through the drilled hole in the roof and passed through the bolt hole **36** on the left sheathing tab **30**, that is on top of the bolt hole **36** on the left strengthening tab **32**. A nut **43** is threaded onto the threads of the carriage bolt **41** and tightened down.

The previously weak connection between the roof and wall is now anchored together. If hurricane winds try to lift the rafter **R**, or the roofing material **M** and roof sheathing **S**, the blocking **F**, wall sheathing **W** and top plate **T** are now secured together with them, and will collectively resist uplift.

If strong winds hit the house wall, shown in FIG. 6, from the right, pressure will try and push the wall **W** in. Many rafters **R** were birds-mouthed, or had a flat notch cut on the bottom to prevent thrusting or the roof weight trying to push the wall outward. Only the toe-nailed connection prevented the wall from being blown in. Now the cyclone clip's strong connection to the rafter **R**, blocking **F**, and roof **S** will prevent the wall from moving inward.

If the strong winds hit the house wall from the left, internal house pressure tries to blow the wall outward. The cyclone clip **16** forms an upside-down buttress, with the rafter tabs **25** and **26**, and offset plate **19** forming the angled buttress stay that prevents the wall sheathing **W** from bowing outward or detaching from the wall.

Earthquakes can push a house upward and shake it side to

side. The upward movement can detach the roof from the wall because it is heavier and would have more momentum. Side or lateral movement can detach or twist the rafters, but the strong connection between all the structural members shown on FIG. 6 prevents detachment.

Another advantage shown in this side view is that nothing hangs down below the rafter **R**. When the cyclone clip **16** is painted to match the house, it will not be noticed. This appeals to homeowners and architects.

The cyclone clip's strong connection between the roof sheathing **S**, rafter **R**, outside wall **W**, and top plate **T** prevent detachment between the roof and wall during upward movement. The strong connection between the roof sheathing **S**, rafter **R**, frieze board **F**, and top plate **T** prevent twisting or detachment of rafters **R** and top plate **T**.

Many pictures of damage caused by Hurricane Andrew in 1992 show the roof sheathing missing from the leading edge of a house. This pressurized the house with wind, blowing the leeward part of the house away and letting rain ruin everything in the house. The cyclone clip **16** ties down the leading edge of roof sheathing preventing detachment of the roofing material **M** and roof sheathing **S** from the rafter **R**.

The roof plate **39** can hold down any type of roofing material **M**. It can hold down wood or composition shingles, metal roofs, and man-made material roofs. With a thin pad under the roof plate **39**, clay tiles can be held down. Now solar panels, and satellite dishes can be secured under the roof plate **39** and safely bolted down to the roof and underlying structural members.

Conclusion, Ramifications, and Scope of Invention

The typhoon clip and cyclone clip are true retrofits that help protect a house from the effects of hurricanes and earthquakes. Both clips hold the roof securely to the outside wall. The typhoon clip helps prevent a roof rafter from lifting,

twisting, moving in toward the house, moving out from the house, moving to the left, and moving to the right. The cyclone clip does the same and holds down the roofing material and roof sheathing.

Both clips also hold the outside wall sheathing securely to the wall. The typhoon clip and cyclone clip help prevent the outside sheathing from bowing out, bowing in, separating from the wall, riding over each other, and splitting.

Both clips turn the outside wall into a strong shear-wall and prevent the wall from racking. One progressive die can be used to make both clips with little waste of material.

Thus the reader can see that the hurricane and seismic connectors of this invention are unique, strong, permanent, functional, and necessary. They are also simple and economical to make, requiring simple tool and dies and no welding.

This invention solves the problem of retro-fitting houses to minimize high wind and seismic dangers by using an ingenious and practical connector. Many homeowners stay in their house during hurricanes, because they do not want to be caught in traffic jams trying to escape the fury, they live on a small island, or they are caught unaware.

While my above description contains many specificities, these should not be construed as limitations on the scope of the invention, but rather as an exemplification of one preferred embodiment thereof. Many other variations are possible.

For example, since the connectors are on the outside of a building, the shape can be changed slightly to make them more architecturally appealing on certain types of houses. To fit on some architectural styles of houses, the shape can be changed slightly without comprising the structural integrity of the clip. The thickness of the connector can be altered slightly, or have beveled edges or chamfer.

Rubber, plastic, foam, or resilient pads could be inserted between the connector and the outside sheathing. This would help absorb the earthquake forces without cracking, and deaden the

shocks, and after-shocks.

The roof plates could have a rubber washer, O-ring, or silicone seal where it goes through the roof in order to make the connection water-proof. This will allow the tie to hold roof sheathing to the rafter, without letting water into the house. The tie could use this rubber to reduce loading and deaden shocks from a seismic event.

The roof plate is comprised of a generally flat steel plate . Since the steel plate will be exposed to the elements, it can be of stainless steel, or painted to match the roof. It can be copper-coated or made from strong plastics or man-made material. It can be textured to match shake shingles or have an s-curve shape or c-shape in order to fit the hills and valleys of a clay tile roof. It can have an arch in the middle in order to hold down solar panels or satellite dishes.

The roof plate can be rectangular square, or curved. A diamond-shape or a banana-shape would look pleasing from the street and will shed water when installed with the point or arch, toward the top of the house.

Some rafters are set next to the horizontal ceiling joist. In order to fit on a rafter and joist, the opening between the rafter tabs and webs would have to be doubled. The width of the clip would also increase. This type of clip could also fit on rafters and trusses that are doubled-up.

To fit on an infinite variety of houses, the connectors could be made of two or more pieces. The pieces could be held together by nuts and bolts in slotted holes, so that the connector could span doubled-up rafters, odd-sized rafters, logs, or trusses.

The invention could use different manufacturing techniques including manipulated sheet metal, casting, forging, extrusion, and plastic molds or injection. There can also be minor variations in color, size, and materials.

This invention was over-designed in order to exceed building codes in force or any that can be anticipated. Many areas have no

codes for retrofit's because, prior to this invention, there were no workable ties that could be retrofit to most buildings. Lag bolts, nails, screws, or bolts and washers could be used to fasten the connectors to the house.